CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary and Advanced Level

MARK SCHEME for the November 2004 question papers

9709 MATHEMATICS 8719 HIGHER MATHEMATICS

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8719/07, 9709/07 – Paper 7 (Probability and Statistics 2) maximum raw mark 50

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the *Report on the Examination*.

• CIE will not enter into discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.

Grade thresholds taken for Syllabus 8719 and 9709 (Mathematics and Higher Mathematics in the November 2004 examination.

	maximum	minimum mark required for grade:					
	mark available	А	В	E			
Component 7	50	41	38	23			

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.

Mark Scheme Notes

Marks are of the following three types:

- www.papaCambridge.com Μ Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.
- А Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).
- В Mark for a correct result or statement independent of method marks.
- When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol $\sqrt{}$ implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.
- B2 or A2 means that the candidate can earn 2 or 0. Note: B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking g equal to 9.8 or 9.81 instead of 10.

The following abbreviations may be used in a mark scheme or used on the scripts:

- AEF Any Equivalent Form (of answer is equally acceptable)
- www.PapaCambridge.com AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
- BOD Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
- CAO Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)
- CWO Correct Working Only – often written by a 'fortuitous' answer
- ISW Ignore Subsequent Working
- MR Misread
- PA Premature Approximation (resulting in basically correct work that is insufficiently accurate)
- SOS See Other Solution (the candidate makes a better attempt at the same question)
- SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

Penalties

- MR -1 A penalty of MR -1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through $\sqrt{}$ " marks. MR is not applied when the candidate misreads his own figures - this is regarded as an error in accuracy. An MR-2 penalty may be applied in particular cases if agreed at the coordination meeting.
- PA -1 This is deducted from A or B marks in the case of premature approximation. The PA -1 penalty is usually discussed at the meeting.



November 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 8719/07 AND 9709/07

MATHEMATICS AND HIGHER MATHEMATICS Paper 7 (Probability and Statistics 2)

Page 1Mark SchemeSyllab1 $\lambda = 2.3 \times 3 = 6.9$ GCE AS/A LEVEL EXAMINATIONS – NOVEMBER 20048719 and 971 $\lambda = 2.3 \times 3 = 6.9$ M1A1P(6, 7, 8) = $e^{-6.9} \left(\frac{6.9^5}{6!} + \frac{6.9^7}{7!} + \frac{6.9^9}{8!} \right)$ M1For attempt at Poisson, any mean2(i) $\overline{X} \sim N\left(6.7, \frac{3.7}{300}\right)$ A142(ii) $\overline{X} \sim N\left(6.7, \frac{3.7}{300}\right)$ M1For standardising, (with or without 300 in denom) $z_1 = \frac{6.8 - 6.7}{3.11/300} = 0.5587$ A1For two correct expressions for z $z_2 = \frac{6.5 - 6.7}{0.573} = -1.117$ For subtracting 2 probabilities $z_1 = \frac{6.5 - 6.7}{1.01/300} = 0.5607$ A1For orecret answer(ii)300 is large, so \overline{X} is approx normal even if X is not i.e. CLT applicationB11For reference to large n and/or CLTB1For orecret expression, (from formulae sheet or equiv.) $s^2 = \frac{1}{149} (159252 - \frac{4080^2}{150}) = 324$ M1For ore of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (ii)94% CI = 27.2 + 1.882 $\times \sqrt{\frac{324}{150}}$ M1For ore of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (iii)94% CI = 27.2 + 1.882 $\times \sqrt{\frac{324}{150}}$ M1For ore of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (iii)94% CI = 27.2 + 1.882 $\times \sqrt{\frac{324}{150}}$ M1For correct expression with their $s / \sqrt{150}$, $zand \overline{x}$ (iii)94% CI = 27.2 + 1.882 $\times \sqrt{\frac{324}{150}}$ M1For correct expression with their $s / \sqrt{150}$, $zand \overline{x}$ (iii)94% CI = 27.2 + 1.882 $\times \sqrt{160}$ B1P or corre						422	
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2(i) $\overline{x} - N\left(6.7, \frac{3.1^2}{300}\right)$ M1For standardising, (with or without 300 in denom) $z_1 = \frac{6.8 - 6.7}{3.1/\sqrt{300}} = 0.5587$ A1For two correct expressions for z $z_2 = \frac{6.5 - 6.7}{3.1/\sqrt{300}} = -1.117$ A1For subtracting 2 probabilitiesProbe = $0(0.5587) - \{1 - \Phi(1.117)\}$ = 0.7119 - (1 - 0.8679)A14ii)300 is large, so \overline{x} is approx normal even if X is not i.e. CLT applicationM1For reference to large n and/or CLT3(i) $\overline{x} = \frac{4080}{150} = 27.2$ B1For orrect expression, (from formulae sheet or equiv.) $s^2 = \frac{1}{149} \left(159252 - \frac{4080^2}{150} \right) = 324$ B1For one of correct form form late sheet or equiv.)(ii) 94% CI = $27.2 \pm 1.862 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.862 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.862 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.862 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.862 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{S}{\sqrt{n}}$ or $\overline{x} - z \times \frac{S}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.625 \pm 114, 7^2 \times 5 \pm 51$ B12For wariance $7^2 \times 5 \pm 5^2 \times 2$ (iii) 94% CI = $27.2 \pm 1.6266 \pm 23.8$ M1For orecret mean and variance of $4M + 3W - N(14, 566) \pm 23.6$ $M = 1$			= 0.428	A1	4	For correct answer	
$\begin{aligned} z_1 &= \frac{6.8 - 6.7}{3.1/\sqrt{300}} = 0.5587 \\ z_2 &= \frac{6.5 - 6.7}{3.1/\sqrt{300}} = -1.117 \\ \text{Prob} &= \Phi(0.5587) - (1 - \Phi(1.117)) \\ &= 0.7119 - (1 - 0.8679) \\ &= 0.580 \end{aligned} \qquad \text{A1} \qquad \text{For subtracting 2 probabilities} \\ \text{A1} & \textbf{4} \text{For correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \text{For subtracting 2 probabilities} \\ \text{A1} & \textbf{4} \text{For correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{4} \text{For correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{4} \text{For correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\end{aligned}$ $\begin{aligned} \text{H1} & \textbf{5} \text{ or correct answer} \end{aligned}$ $\end{aligned}$	2(i)	<i>X</i> ∼N	$\left(6.7, \frac{3.1^2}{300}\right)$	M1		For standardising, (with or without 300 in denom)	
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(ii)300 is large, so \overline{X} is approx normal even if X is not i.e. CLT applicationB11For reference to large n and/or CLT $3(i)$ $\overline{x} = \frac{4080}{150} = 27.2$ $s^2 = \frac{1}{149} \left(159252 - \frac{4080^2}{150} \right) = 324$ B1For 4080/150 $3(i)$ $\overline{x} = \frac{4080}{149} = 27.2$ $149 \left(159252 - \frac{4080^2}{150} \right) = 324$ B1For correct expression, (from formulae sheet or equiv.) A1(ii) 94% CI = $27.2 \pm 1.882 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{s}{\sqrt{n}}$ or $\overline{x} - z \times \frac{s}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.882 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{s}{\sqrt{n}}$ or $\overline{x} - z \times \frac{s}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.882 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{s}{\sqrt{n}}$ or $\overline{x} - z \times \frac{s}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.882 \times \sqrt{\frac{324}{150}}$ M1For one of correct form $\overline{x} + z \times \frac{s}{\sqrt{n}}$ or $\overline{x} - z \times \frac{s}{\sqrt{n}}$ (iii) 94% CI = $27.2 \pm 1.882 \times \sqrt{\frac{324}{150}}$ M1For correct expression with their $s / \sqrt{150}, z$ and \overline{x} (iii) 94% CI = $27.2 \pm 1.882 \times \sqrt{\frac{324}{150}}$ M1For correct expression with their $s / \sqrt{150}, z$ and \overline{x} (iii) $5M + 2W \sim N(355 + 114, 7^2 \times 5 + B1$ B1For mean = $5 \times 71 + 2 \times 57$ (iii) $Y \sim 4M + 3W \sim N(455, 271)$ B1For correct mean and variance of $4M + 3W$ $X - Y \sim (5M + 2W) - (4M + 3W)$ M1For adding their two variances and subtracting		=	= 0.7119 – (1 – 0.8679) = 0.580	A1	4	For correct answer	
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$s^{2} = \frac{1}{149} \left(159252 - \frac{4080^{2}}{150} \right) = 324$ $M1$ $s^{2} = \frac{1}{149} \left(159252 - \frac{4080^{2}}{150} \right) = 324$ $M1$ $A1$ S For correct expression, (from formulae sheet or equiv.) A1 S For one of correct form $\overline{x + z \times \frac{s}{\sqrt{n}}} \text{ or } \overline{x} - z \times \frac{s}{\sqrt{n}}$ B1 $For z = 1.881 \text{ or } 1.882 \text{ only}$ For correct expression with their $s / \sqrt{150}, z \text{ and } \overline{x}$ $= (24.4, 30.0)$ $A1$ 4 $For mean = 5 \times 71 + 2 \times 57$ For variance = $7^{2} \times 5 + 5^{2} \times 2$ $(ii) Y \sim 4M + 3W \sim N(455, 271)$ $X - Y \sim (5M + 2W) - (4M + 3W)$ $\sim N(14, 566)$ Mean = 14, s.d. = $\sqrt{5666} = 23.8$ $P (X - Y > 22) = 1 - \Phi \left(\frac{22 - 14}{\sqrt{566}} \right)$ $= 1 - \Phi(0.3363)$ $= 1 - \Phi(0.3363)$ $= 1 - \Phi(0.3363)$ $= 1 - \Phi(0.2363)$ $= 1 - \Phi(0.2363)$ $= 1 - \Phi(0.22)$ $A1$ $M1$ For correct mean and variance of 4M + 3W $H1$ For oth correct (must be s.d.), ft on wrong mean and variance of Y For standardising and using tables, either end, need the sq rt $= 0.260 \text{ or } 0.000$ $A1$ F	3(i)	$\frac{-}{x} = \frac{40}{x}$	$\frac{080}{2} = 27.2$	B1		For 4080/150	
$s^{2} = \frac{1}{149} \left(159252 - \frac{100}{150} \right) = 324$ A1 3 Sheet or equiv.) For correct answer $A1 3 = 5 \text{ For one of correct form}$ For one of correct form $\overline{x} + z \times \frac{s}{\sqrt{n}} \text{ or } \overline{x} - z \times \frac{s}{\sqrt{n}}$ For correct expression with their $s / \sqrt{150}, z \text{ and } \overline{x}$ $= (24.4, 30.0)$ A1 4 For one of correct form $\overline{x} + z \times \frac{s}{\sqrt{n}} \text{ or } \overline{x} - z \times \frac{s}{\sqrt{n}}$ For correct expression with their $s / \sqrt{150}, z \text{ and } \overline{x}$ Or equivalent statement (c.w.o.) $A1 4 = 0 \text{ or equivalent statement (c.w.o.)}$ $A1 4 = 0 or equivalent statement (c.w.o.)$ $A1 4 = 0 \text{ or equivalent statement (c.w.o.)$ $A1 4 = 0 \text{ or equivalent statement (c.w.o.)$ $A1 4 = 0 \text{ or equivalent statement (c.w.o.)$ $A1 4 = 0 \text{ or equivalent statement (c.w.o.)$ $A1 4 = 0 \text{ or equivalent statement (c.w$		1	$1(\dots, 4080^2)$	M1		For correct expression, (from formulae	
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B1 A1ftFor $z = 1.881$ or 1.882 only For correct expression with their $s / \sqrt{150}, z$ and \overline{x} $= (24.4, 30.0)$ A1 4 $4(i)$ $5M + 2W \sim N(355 + 114, 7^2 \times 5 + 5^2 \times 2) \sim N(469, 295)$ B1 $4(i)$ $5M + 2W \sim N(355 + 114, 7^2 \times 5 + 5^2 \times 2) \sim N(469, 295)$ B1 2 For mean $= 5 \times 71 + 2 \times 57$ For variance $= 7^2 \times 5 + 5^2 \times 2$ (ii) $Y \sim 4M + 3W \sim N(455, 271)$ $X - Y \sim (5M + 2W) - (4M + 3W)$ B1 $X - Y \sim (5M + 2W) - (4M + 3W)$ $\sim N(14, 566)$ Mean $= 14, s.d. = \sqrt{566} = 23.8$ $P(X - Y > 22) = 1 - \Phi\left(\frac{22 - 14}{\sqrt{566}}\right)$ $= 1 - \Phi(0.3363)$ $= 1 - 0.631$ or $1 - 0.632$ B1 $A1 = 5$ For standardising and using tables, either end, need the sq rt	(ii)	94% ($CI = 27.2 \pm 1.882 \times \sqrt{\frac{324}{150}}$	M1		For one of correct form $\overline{x} + z \times \frac{s}{\sqrt{n}}$ or $\overline{x} - z \times \frac{s}{\sqrt{n}}$	
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4(i) $5M + 2W \sim N(355 + 114, 7^2 \times 5 + 5^2 \times 2) \sim N(469, 295)$ B1B1For mean = $5 \times 71 + 2 \times 57$ For variance = $7^2 \times 5 + 5^2 \times 2$ (ii) $Y \sim 4M + 3W \sim N(455, 271)$ $X - Y \sim (5M + 2W) - (4M + 3W)$ $\sim N(14, 566)$ Mean = 14, s.d. = $\sqrt{566} = 23.8$ $P(X - Y > 22) = 1 - \Phi\left(\frac{22 - 14}{\sqrt{566}}\right)$ B1For correct mean and variance of $4M + 3W$ For adding their two variances and subtracting their two means For both correct (must be s.d.), ft on wrong mean and var of Y For standardising and using tables, either end, need the sq rt $= 1 - \Phi(0.3363)$ $= 1 - 0.631$ or $1 - 0.632$ $A1$ 5		= (24.	4, 30.0)	A1	4	Or equivalent statement (c.w.o.)	
(ii) $Y \sim 4M + 3W \sim N(455, 271)$ $X - Y \sim (5M + 2W) - (4M + 3W)$ $\sim N(14, 566)$ Mean = 14, s.d. = $\sqrt{566} = 23.8$ $P(X - Y > 22) = 1 - \Phi\left(\frac{22 - 14}{\sqrt{566}}\right)$ $= 1 - \Phi(0.3363)$ = 1 - 0.631 or 1 - 0.632 = 0.269 or 0.260	4(i)	5M + 2 5 ² × 2	2W ~ N(355 + 114, 7 ² ×5 +) ~ N(469, 295)	B1 B1	2	For mean = $5 \times 71 + 2 \times 57$ For variance = $7^2 \times 5 + 5^2 \times 2$	
$\begin{array}{c c} X - Y \sim (5M + 2W) - (4M + 3W) \\ \sim N(14, 566) \\ Mean = 14, s.d. = \sqrt{566} = 23.8 \\ P(X - Y > 22) = 1 - \Phi\left(\frac{22 - 14}{\sqrt{566}}\right) \\ = 1 - \Phi(0.3363) \\ = 1 - 0.631 \text{ or } 1 - 0.632 \\ = 0.269 \text{ or } 0.269 \end{array}$ $\begin{array}{c c} M1 \\ M1 $	(ii)	Y~41	M + 3W ~ N(455, 271)	B1		For correct mean and variance of	
$ \begin{array}{l} \sim N(14, 566) \\ \text{Mean} = 14, \text{ s.d.} = \sqrt{566} = 23.8 \\ \text{P}(X - Y > 22) = 1 - \Phi\left(\frac{22 - 14}{\sqrt{566}}\right) \\ = 1 - \Phi(0.3363) \\ = 1 - 0.631 \text{ or } 1 - 0.632 \\ = 0.269 \text{ er} 0.269 \end{array} $		X – Y	~ (5M + 2W) – (4M + 3W)	M1		For adding their two variances and	
$P(X - Y > 22) = 1 - \Phi\left(\frac{22 - 14}{\sqrt{566}}\right)$ $= 1 - \Phi(0.3363)$ $= 1 - 0.631 \text{ or } 1 - 0.632$ $= 0.269 \text{ or } 0.269$ $A1 = 5$ For sampling mean and var of Y For standardising and using tables, either end, need the sq rt $F = 1 - \Phi(0.3363)$		~ N(14 Mean	4, 566) = 14, s.d. = $\sqrt{566} = 23.8$	A1ft		Subtracting their two means For both correct (must be s.d.), ft on	
$= 1 - \Phi(0.3363)$ = 1 - 0.631 or 1 - 0.632 = 0.269 or 0.260		P (X -	$-Y > 22) = 1 - \Phi\left(\frac{22 - 14}{\sqrt{566}}\right)$	M1		wrong mean and var of Y For standardising and using tables, either end, need the sq rt	
		= 1 = 1 = 0 36	Ф(0.3363) 0.631 or 1 – 0.632 38 or 0.369	Δ1	5	For correct answer	

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		1		134
5(i)	$\lambda = 1.8$ P(X > 2) = 1 - [P(0) + P(1) + P(2)]	M1 A1		For attempt at Poisson, any mean For correct mean
	$= 1 - e^{-1.8} \left(1 + 1.8 + \frac{1.8^2}{2!} \right)$	M1		For finding $1 - P(0) - P(1) - P(2)$ or $1 - P(0) - P(1)$
	= 1 – 0.7306 = 0.269	A1	4	For correct answer SR1 Normal scores B1 for $2.5 - 1.8/\sqrt{(1.7988)}$ SR2 Binomial scores M1 for complete method loading to final answer of 0.269
				A1
(ii)	$\lambda = n/1500 \mathrm{or}$	B1		For correct Poisson mean
	$P(0) < 0.01$ i.e. $e^{\frac{-n}{1500}} < 0.01$	M1		For equation or inequality involving their P(0) and 0.01
	<u>−n</u> 1500 < In 0.01			
OR	n > 6907.7 n = 6908 $(1499/1500)^n < 0.01$	A1 (B1) (M1)	3	For correct answer For correct Binomial p For correct equation/inequality involving their P(0) and 0.01
	<i>n</i> = 6906	(A1)		For correct answer
0(1)	$\begin{bmatrix} 1 \\ 1 \\ 1 \\ 2 \\ 1 \\ 1$	M1		For attempt at integrating and using limits
6(1)	$\int_{0.5}^{3(1-x)} dx = \left[\frac{1}{-3} \right]_{0.5}^{-3}$	A1		Or equivalent correct integration (missing factors of 3 can still gain A1)
	$= [0] - [-1](0.5)^3 = 0.125$	A1	3	For correct answer
(ii)				
E(X)=	$\int_{0}^{1} 3x(1-x)^{2} dx = \int_{0}^{1} 3x - 6x^{2} + 3x^{3} dx$	M1		For attempt at $\int x f(x) dx$ with or without limits
	$= \left[\frac{3x^2}{2} - \frac{6x^3}{3} + \frac{3x^4}{4}\right]_0^1$	A1		For 2 or 3 correct parts of the integral (missing factors of 3 can still gain A1)
	$=\frac{3}{2}-2+\frac{3}{4}=0.25$	A1		For correct answer
	Var (X) = $\int_{0}^{1} 3x^{2}(1-x)^{2} dx - [E(X)]^{2}$	M1		For attempt at $\int x^2 f(x) dx - [E(X)]^2$ i.e. $-[E(X)]^2$ must be
	1			seen even if it is ignored in the next line
	$= \int_{0}^{3} 3x^{2} - 6x^{3} + 3x^{4} dx - (0.25)^{2}$	B1		For 2 or 3 correct parts of the integral (missing factors of 3 can still gain A1)
	$= \left\lfloor \frac{3x^3}{3} - \frac{6x^4}{4} + \frac{3x^5}{5} \right\rfloor_0^1 - (0.25)^2$			
	= 0.0375	A1	6	For correct answer

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7(i)	not random, could be more light etc.	B1	1	Any sensible reason	atigg
(ii)	One-tailed test H_0 : p = 0.35 H_1 : p > 0.35 P(8) = 0.35 ⁸ = 0.000225 P(7) = 0.35 ⁷ × 0.65 ¹ × ₈ C ₇ = 0.0033456 P(6) = 0.35 ⁶ × 0.65 ² × ₈ C ₆ = 0.02174 P(5) = 0.35 ⁵ × 0.65 ³ × ₈ C ₅ =	B1 B1 M1* M1		For correct answer For H ₀ and H ₁ For attempt at any Bin expression P(0) – P(8) For summing probabilities starting at P(8) and working backwards until > 0.05 (or equiv.)	Se.com
	Crit region is 6, 7, 8 survive	A1		For correct answer	
	4 is not in CR (OR $Pr(\geq 4) = 0.294$ and comparison 0.5/or equiv.)	M1*de	р	For deciding whether 4 is in their CR or not OR finding relevant prob and showing comparison	
	⇒ no significant improvement in survival rate	A1ft	7	For correct conclusion (ft from their critical region)	
(iii)	Saying no improvement when there is	B1	1	Or equivalent, relating to the question	r
(iv)	Need P(0, 1, 2, 3, 4, 5) or 1 - P(6, 7, 8) P(8) = 0.4^8 (= 0.0006554) P(7) = $0.4^7 \times 0.6 \times {}_8C_7$ (= 0.007864) P(6) = $0.4^6 \times 0.6^2 \times {}_8C_6$ (= 0.04128) $1 - (0.4^8 + 0.4^7 \times 0.6 \times {}_8C_7 + 0.4^6 \times 0.6^2 \times {}_8C_6)$ = 0.950	M1	ŋ	For identifying type II error	*
	- 0.950	AT	2		